

THE CONSTITUTION, DISTRIBUTION AND RELATIONSHIPS OF THE AUSTRALIAN DECAPOD CRUSTACEA

A PRELIMINARY REVIEW*

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Synopsis

Approximately 1200 species are recorded from Australia, representing 57 of the 73 known decapod families. These are placed in 361 genera. About 54% of the species belong to the Brachyura. Xanthid and majid crabs as well as parastacid crayfish are well represented. Little is known of many natant groups. The majority of species are tropical and many are widespread northern forms; there are a smaller number of widespread southern forms. The tropical fauna shows close affinities with the faunas of other Indo-West Pacific areas.

INTRODUCTION

There are approximately 1,200 species of Crustacea Decapoda currently recognized and recorded from the Australian area representing 57 of the 73 families into which the living members of this order are at present divided. The Australian species range in size from the transparent, planktonic, sergestid shrimp *Lucifer*, a few mm. in length, through the whole range of variously-sized prawns, crayfish, hermit crabs and true crabs, up to the giant xanthid crab of the southern continental shelf, *Pseudocarcinus gigas*, reaching at least 30 lb. in weight and 13 inches across the carapace. Decapods are found on land, in freshwater, on sandy beaches, in mangrove swamps and in the sea, from the surface of the open ocean through all depths, and on all bottoms, down to the floor of the nearby hadal trenches of this area. On the continent itself, species occur from the upper slopes of the Snowy Mountains, through the streams and swamps of almost all land and vegetation types, to the intermittent waters of some parts of the inland deserts.

The present review is an attempt to systematize certain aspects of the currently available knowledge of the diversity, distribution and relationships of the Australian Decapod fauna.

The data used in this review come from a series of largely uncritical family and subfamily checklists prepared from the decapod literature index held in the Crustacea Department at the Australian Museum. This index was initiated by A. R. McCulloch early this century, but has been greatly expanded and developed by F. A. McNeill since then. McNeill in fact, since his retirement as Curator of Crustacea in 1961, has still remained largely responsible for keeping this unique and invaluable index up to date. Without its help we would have been unable to present this study in its present form. The index is basically a cross-referenced file of decapod species recorded in published literature for Australia and nearby areas. It pays special regard to synonymy, recorded localities and illustrations. It also contains numerous unpublished observations, new records, extensions to range, suspected

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synonyms, drawings, photographs and colour sketches. Though incomplete, its imperfections are largely known, and it is being continually expanded and developed. There are at present approximately 28,000 items individually indexed and systematically arranged in this file.

The present review is restricted to Australian species and localities actually published, in press or in draft manuscript known to us in July, 1967. In a very few cases certain clear, specific omissions or new state records, known to several workers on our fauna, and not in the above categories, are included. Many new records for Australia, recorded only in the Museum literature file, or known only to workers with an Australian group under review, are not included in the present study. No attempt has been made to search the collections of the Australian Museum, or other State museums, for extensions of range or to confirm the presence or absence of species from areas considered in the tables below. Such a search was not considered necessary or practicable at this stage; in the opinion of the authors, the extra details obtained would not alter to any significant extent the overall conclusions about relationships and distribution patterns drawn here.

The classification used at the suprageneric level in this review is mainly that set out in Balss (1957), though this has been modified in some instances to suit our views. For example, Holthuis (1955) is followed for the caridean shrimps and prawns, Griffin (1966) for the majid spider crabs and Stephenson and Campbell (1960) for the portunid swimming crabs.

HISTORICAL

The only previous attempt to review the Australian decapod Crustacea was made by Haswell in 1882. His well-known "Catalogue of the Australian Stalk- and Sessile-Eyed Crustacea" was published by the Australian Museum as the first of a series of similar catalogues on various groups of the Australian fauna. Haswell's section on the Decapoda in this volume includes 381 species representing 152 genera. These genera are distributed among 37 families or family equivalents. Geographical information is very sparse and usually restricted to one or two individual localities for each species; no summary or distribution analysis is included in this work. Assuming that all the species recorded by Haswell still stand in the Australian list, the 1882 Catalogue covers only 32% of the decapods now known from this area.

Since Haswell's major work on this order, a number of family and generic reviews have appeared, covering either the whole of Australia or a restricted area. A number of important expedition reports, covering usually one major collection for a restricted area, have also been issued in this period. Only three groups of Australian decapods are considered to be adequately covered by modern systematic reviews: the penaeid prawns (Dall, 1957; Racek and Dall, 1965), the majid spider crabs (Griffin, 1966) and the portunid swimming crabs (Rees and Stephenson, 1966; Stephenson, 1961, 1962; Stephenson and Campbell, 1959, 1960; Stephenson and Hudson, 1957; Stephenson, Hudson and Campbell, 1957). Other published systematic and geographic accounts of major significance are as follows: freshwater parastacid crayfish (Clark, 1936, 1941; Riek, 1956); parastacid crayfish of Queensland, of Western Australia and of Tasmania (Riek, 1951*b*, 1967*a*, 1967*b*); porcellanid crabs of Western Australia (Haig, 1965); oxystome and gymnopleuran crabs of Western Australia (Tyndale-Biscoe and George, 1962); freshwater potamid crabs and the zoogeography of freshwater decapods in general (Bishop, 1963, 1967); *Ocypode* crabs of Western Australia (George and Knott, 1965), and an illustrated account of the decapods of South

Australia (Hale, 1927). Expedition reports of importance are as follows: Abrolhos Islands, Western Australia (Percy Sladden Trust Expedition—Montgomery, 1931); Low Isles and adjacent reefs, Queensland (Great Barrier Reef Expedition—McNeill, 1968); Port Curtis district, Queensland (Grant and McCulloch, 1906); continental shelf off Sydney, New South Wales (*Thetis* Expedition—Whitelegge, 1900); continental shelf off south-eastern and southern Australia (*Endeavour* Expedition—Rathbun, 1918, 1923; Schmitt, 1926); shelf and deep waters off Tasmania and southern Australia (B.A.N.Z.A.R. Expedition—Hale, 1941), and south-western Australia (Hamburg Museum Expedition—Balss, 1935).

SIZE AND CONSTITUTION OF THE FAUNA

The 1200 or so species of decapod crustaceans recorded from Australia belong to 361 genera and 57 families. The largest systematic group is the Brachyura or true crabs which includes about 54% of the total species (Table 1). The smallest group is the Macrura Reptantia (crayfish and allies) which contains almost as many species as the Anomura or hermit crabs but only half the number of genera; the Natantia (shrimps and prawns) comprise less than three times as many species as the reptant macrurans, but spread through almost four times as many genera.

TABLE 1
Size of the four major systematic groupings in the Australian decapod fauna

Group		Number of Families	Number of Genera	Number of Species	Percentage of Total Species
Natantia ..	Shrimps and prawns	16	82	299	25.1
Macrura					
Reptantia	Crayfish, etc.	4	21	119	10.0
Anomura ..	Hermit crabs, etc.	14	41	129	10.8
Brachyura	True crabs	23	217	643	54.1
Total		57	361	1190	100.0

The largest family is the Xanthidae with 47 genera and 166 species (Table 2). The largest genera are the xanthids *Actaea* and *Pilumnus* with 27 species each. The Parastacidae with only 11 genera contains at least 91 species; included are three particularly large genera, *Cherax*, *Euastacus* and *Engaeus*. The average number of genera per family is 6.3, the average number of species per family is 21 and the average number of species per genus is 3.3.

Considering the larger families and genera (Table 2) we find that 17 of the families (30% of the familial total) contain more than 5 genera (in all 273 genera—75% of the generic total), that 23 families (42.1% of the familial total) contain 998 species (83.9% of the specific total) and that 23 genera (6.4% of the generic total) account for 365 species (30.4% of the specific total). In these larger groups then, the average number of genera per family is 16, the average number of species per family is 45 and the average number of species per genus is 16.

Among the best represented groups of decapods in Australia are the Parastacidae (freshwater crayfish)—probably about 80% of the total world species; the Mictyridae (soldier crabs)—all three species are represented in Australia, and the anomuran family, the Lomisidae (one species), which

is confined to Australia. The intertidal grapsid crabs, although one of the larger families (4% of the total marine species, Table 5), is in fact rather poorly represented in Australia—less than 25% of the total known species occur here; particularly noticeable is the paucity of varunines. The terrestrial groups—Gecarcinidae (land crabs) and Coenobitidae (robber crabs and land hermits)—are very poorly represented with only three species out of a world total of about 15. Several families of natants are poorly represented in the Australian fauna. Particularly noticeable is the paucity of pandalid and crangonid shrimps. These families are especially well represented in northern hemisphere waters. The Australian fauna includes at present only six pandalids (world total about 112) and 10 crangonids (world total about

TABLE 2

List of the large families (containing more than 10 genera) and genera (containing 10 or more species)

	Family	No. of Genera	No. of Species	Genus	No. of Species	Genus	No. of Species				
20 or more genera	100 species	47	166	Actaea	27	Pilumnus	27				
				Carpilodes	10	Xantho	10				
11-19 genera	50-99 species	43	93	Hyastenus	13						
				Parastacidae	11	91	Cherax	24	Euastacus	19	
	11-19 genera	50-99 species	15	80	Engaeus	15					
					Thalamita	23	Portunus	18			
					Charybdis	14					
					Leucosidae	19	74	Leucosia	15	Ebalia	10
					Paguridae	15	58	Pagurus	12		
					Penaeidae	15	50	Metapenaeopsis	10		
					Palaemonidae	19	48	Macrobrachium	12		
					Grapsidae	17	43	Sesarma	15		
20-49 species	20-49 species	14	21	Ocyrodidae	11	41	Macrophthalmus	15	Uca	13	
				Goneplacidae	14	21					
				Porcellanidae	8	38	Petrolisthes	10			
				Alpheidae	6	31	Alpheus	17			
6-10 genera	10-19 species	10	29	Parthenopidae	10	29	Parthenope	16			
				Dromiidae	9	24					
				Hippolytidae	9	19					
				Atyidae	6	19					
				Scyllaridae	5	15	Scyllarus	10			
5 genera or less	10-19 species	3	12	Calappidae	3	14					
				Pinnotheridae	3	12					
				Palinuridae	4	11					
5 genera or less	10-19 species	3	11	Galatheididae	3	11					
				Hymenosomidae	3	10					

140). A number of other natant families—stenopodids, sergestids and processids—present in Australia in small numbers, conform to a general world familial pattern of a few species, often with a limited geographical distribution, in each major area. Less than 1/5 of the known Atyidae (freshwater shrimps) and less than 1/10 of the Potamidae (freshwater crabs) occur in Australia—this contrasts with the strong representation of the other freshwater family, the parastacid crayfish.

MAJOR HABITAT GROUPINGS

The vast majority of the species (90%) are exclusively marine. However, all of the four major systematic groupings are represented on land or in freshwater. The list below gives the names of the families (and in some cases genera) occurring in freshwater, on land and in the various zones of the sea. Three families, including 18 genera and more than 116 species,

are confined to freshwater and four other genera (of three families) also occur in freshwater. Two genera containing four species belonging to two families are found on land.

The intertidal zone is dominated by representatives of five families which do not normally occur subtidally (a total of more than 100 species). Thirteen other families are strongly represented intertidally or immediately subtidally; the most important of these are the xanthids, portunids, majids and leucosiids.

Five families contain mainly pelagic or bathypelagic oceanic species and the representatives of 20 families are characteristic of the shelf. Particularly important shelf groups are the majids, parthenopids, leucosiids, portunids and dromiids. A list of these habitat groupings is given below.

Freshwater Families and Genera

Restricted freshwater families: Atyidae, Parastacidae, Potamidae.

Freshwater genera or species: *Macrobrachium* and *Palaemonetes* (in part) (Palaemonidae); *Halicarcinus lacustris* (Hymenosomidae); *Varuna litterata* (partly) (Grapsidae).

Terrestrial Families

Restricted terrestrial families: Coenobitidae, Gecarcinidae.

Littoral (i.e., Intertidal) Families

Restricted littoral families: Thalassinidae, Lomisidae, Mictyridae, Grapsidae, Ocypodidae.

Other families with some littoral (but not exclusively littoral) representatives: Palaemonidae, Alpheidae, Gnathophyllidae, Hippolytidae, Stenopodidae, Axiidae, Callinassidae, Dromiidae, Calappidae, Leucosiidae, Majidae, Portunidae, Xanthidae.

Oceanic Families

Restricted pelagic or bathypelagic families: Penaeidae (in part only), Sergestidae, Oplophoridae, Pasiphaeidae, Grapsidae (*one genus only—Planes*).

Families characteristic of Shelf and Shallow Waters

Penaeidae, Ogyrididae, Stenopodidae, Palinuridae, Scyllaridae, Laomediidae, Galatheidae, Albumeidae, Dromiidae, Raninidae, Calappidae, Homolidae, Leucosiidae, Majidae, Parthenopidae, Hymenosomidae, Portunidae, Xanthidae, Goneplacidae, Cancridae.

COMMERCIAL GROUPS

The commercial species are largely macrurous—natant prawns and reptant crayfish. The major families are the Penaeidae, Palinuridae and Portunidae (part only) with 13 genera and about 50 species being fished commercially. The Scyllaridae and Parastacidae are of minor economic importance.

GEOGRAPHICAL DISTRIBUTION WITHIN AUSTRALIA

The main feature of the patterns of geographical distribution of the marine decapods in Australia is the fairly clear partitioning of the fauna into a northern (tropical) group and a southern (temperate) group, the former being very much the larger. However, there is no clear geographical

dividing line between these two groups and the junction is in the form of a broad transition zone on the east and west coasts. This is well shown by plotting the distributions of a large number of tropical and temperate species on the one map (Fig. 1). In the case of the majid spider crabs (22 species occurring mainly in northern waters, 15 in temperate areas), it can be seen that this transition zone extends on the east coast from about Cape Howe in the south to Hervey Bay in the north, and on the west coast from about Cape Leeuwin in the south to about Shark Bay in the north.

About 160 species have a wide northern distribution extending from north-western Australia to Queensland and sometimes further south to New



Fig. 1. Map of Australia showing known distributions of 22 mainly northern species and 15 mainly southern species of majid crab, indicating the extent of the transition zones between the northern tropical and southern temperate faunas.

South Wales or Victoria (Tables 3 and 4, Fig. 2). Particularly notable in this regard are the relatively large number of portunids, leucosiids, parthenopids, calappids, palinurids, porcellanids and penaeids; a smaller proportion of the larger families, such as Xanthidae and Majidae, are also widespread northern forms. It should be pointed out that although the distributions of these species are considered to be continuous, a very large number (about 2/3) of these widespread northern species are not known from the Gulf of Carpentaria and the Torres Strait area.

More than 40 species have widespread southern distributions extending from New South Wales or Victoria to south-western Australia. Particularly notable here are majids, grapsids and hymenosomids; the dromiids are also well represented in this southern group, although their distributions are more limited according to the information currently available. Five of these widespread southern species occur from southern Queensland to central Western Australia.

Less obvious than these northern and southern groups are ones which are either eastern or western (Fig. 7). The number of species extending along the whole eastern or western coasts are few and generally eastern species are either northern or southern. Inasmuch as some species are known

TABLE 3
Number of species showing particular distribution—northern, eastern and southern

Family	Distributional Limits															
	Total Species	W.A.-N. Qld.	W.A.-Qld.	W.A.-N.S.W.	N. Qld.-Qld.	N. Qld.-N.S.W.	N. Qld.-Vict.	Qld.-N.S.W.	Qld.-Vict.	Qld.-S.A.	N.S.W.-S.A.	N.S.W.-W.A.	Vict.-W.A.	S.A.-W.A.	N.S.W.-Vict.	Vict.-S.A.
Xanthidae ..	58	1	15	10	18	3	—	2	—	2	3	2	1	1	—	—
Majidae ..	38	2	10	1	3	—	2	1	2	2	3	5	3	1	3	—
Portunidae ..	41	—	12	17	3	2	—	3	—	—	2	—	—	1	1	—
Leucosiidae ..	25	6	9	2	1	—	—	1	1	—	2	—	1	—	2	—
Paguridae ..	16	—	2	2	2	—	—	2	—	—	1	1	—	—	5	1
Palaemonidae ..	13	1	2	—	5	—	—	—	—	—	2	1	—	—	—	2
Grapsidae ..	20	—	2	2	6	—	—	3	1	1	—	1	1	—	—	3
Ocypodidae ..	22	2	6	5	3	—	—	4	1	—	—	—	—	—	—	1
Penaeidae ..	18	1	2	9	2	—	—	1	2	—	—	—	—	1	—	—
Porcellanidae ..	12	—	9	2	—	—	—	—	—	—	—	—	1	—	—	—
Alpheidae ..	8	1	1	—	—	3	—	—	—	—	1	—	—	1	—	1
Parthenopidae ..	18	2	4	1	7	—	—	3	—	—	—	—	—	1	—	—
Dromiidae ..	7	—	—	—	—	—	—	1	—	—	4	—	—	—	—	2
Goneplacidae ..	4	—	—	—	1	—	—	1	—	—	1	—	1	—	—	—
Hippolytidae ..	6	—	1	1	—	—	—	—	—	—	3	1	—	—	—	—
Palinuridae ..	8	—	5	—	—	—	—	1	—	—	—	1	—	—	1	—
Calappidae ..	10	—	3	5	—	—	—	1	—	—	—	—	1	—	—	—
Others ..	40	2	4	5	—	—	—	5	1	3	3	6	4	—	4	3
Total ..	364	18	87	62	51	8	2	29	8	8	25	18	12	7	16	13

only from either the east or west coasts there appear to be transition zones in the north around the Torres Strait area and in the south around eastern South Australia. The area around Spencers Gulf in South Australia contains several species which are otherwise common in tropical areas (Fig. 1).

Approximately 130 species have a widespread distribution along the east coast. The majority of these occur along the Queensland coast often to northern New South Wales but a large number occur from Queensland or New South Wales to Victoria, Tasmania or South Australia. One widespread majid, *Oncinopus aranea*, extends from northern Queensland to South Australia and eight others have only slightly more limited distributions. Particularly notable in this eastern group are the Xanthidae with a very large number of species confined to Queensland. At least 20 species of

decapods appear to have a central eastern distribution extending from southern Queensland to northern Victoria.

No separate analysis of western species is given as our distributional data were summarized under State headings only and subdivision of the long Western Australian coastline has not been attempted in detail.

Summarizing the distribution patterns of species occurring outside a single State, the most common is a northern one with a smaller group of species having widespread southern distributions. These two major types are

TABLE 4
Examples of very widely distributed species

Family	Species	Area							
		S.A.	W.A.	N. Qld.	Qld.	N.S.W.	Vict.	S.A.	W.A.
Penaeidae	<i>Penaeus latisulcatus</i>	×	×	×	×	×			
	<i>Hymenopenaeus sibogae</i>		×	×	×	×	×		
Palaemonidae	<i>Anchistus custos</i>	×	×	—	×				
Alpheidae	<i>Alpheus edwardsii</i>			—	×	×	—	×	
Upogebiidae	<i>Upogebia darwinii</i>	×	×	×					
Hippidae	<i>Hippa adactyla</i>	×	×	×	×	×			
Porcellanidae	<i>Polyonyx transversus</i>		×	—	×	×	×		
	<i>Pisidia dispar</i>	×	×	—	×	×			
Dromiidae	<i>Petalomera lateralis</i>				×	×	×	×	×
Leucosiidae	<i>Leucosia anatum</i>		×	×	×	×	—	×	
	<i>Myra mammilaris</i>	×	×	—	×				
Calappidae	<i>Calappa hepatica</i>	×	×	—	×	×			
	<i>Matuta granulosa</i>	×	×	×	×				
Parthenopidae	<i>Ceratocarcinus dilatatus</i>	×	×	×	×				
Majidae	<i>Huenia proteus</i>	×	×	—	×	×			
	<i>Zewa varians</i>		×	×	×	×	×		
	<i>Hyastenus diacanthus</i>		×	×	×	×	×		
	<i>Achaeus brevirostris</i>		×	×	×	×	×		
	<i>Leptomithrax sterno-</i> <i>costulatus</i>				×	×	×	×	×
	<i>Schizophrys aspera</i>	×	×	×	×				
	<i>Micippa philyra</i>	×	×	×					
Xanthidae	<i>Cryptocoeloma haswelli</i>	×	×	×	×				
	<i>Actaea calculosa</i>	×	×	×	×	×			
	<i>Actumnus setifer</i>	×	×	×					
	<i>Pilumnus fissifrons</i>				×	×	×	×	×
	<i>Pilumnus semilanatus</i>	×	×	—	×				
	<i>Ozium truncatus</i>					×	—	×	×
Portunidae	<i>Thalamita sima</i>	×	×	×	×	×			
	<i>Portunus pelagicus</i>	×	×	×	×	×	×	×	×
	<i>Macropipus corrugatus</i>				×	×	×	×	×
	<i>Lissocarcinus polybioides</i>	×	×	—	×	×			
Grapsidae	<i>Leptograpsus variegatus</i>				×	×	×	×	×
	<i>Cyclograpsus audouinii</i>				×	×	×	×	×

characteristic of particular taxonomic groups. Thus portunids, penaeids, parthenopids, ocypodids, porcellanids and palinurids are almost entirely restricted to northern Australia.

A very large number of species in every group is not known from more than one State. In the case of nine families (Oplophoridae, Crangonidae, Callianassidae, Paguridae, Majidae, Palicidae, Xanthidae, Goneplacidae and Grapsidae) more than 2/3 of the species are recorded at present from only one State.

Different families are represented in quite different proportions in different areas as can be seen from Tables 3 to 6 and Fig. 3. Figures 4 and 5 give examples of some of the distribution patterns discussed above. The

families Xanthidae, Majidae and Grapsidae possess several widespread northern as well as southern species. The Hymenosomidae is the only family with 10 species or more which is virtually restricted to southern waters (Queensland species are known, but not, as yet, adequately recorded in the literature). The different distributions are summarized in Table 3 and Fig. 2b.

EXTRA-AUSTRALIAN GEOGRAPHICAL RELATIONSHIPS

Examination of the distribution patterns of the decapod genera represented in Australia shows that almost 50% of those found outside Australia possess species in the Indo-West Pacific area but not outside it, whilst a very slightly smaller number are distributed throughout the Indian, Pacific and Atlantic Oceans. The list below groups the families according to the relationships of the included genera.

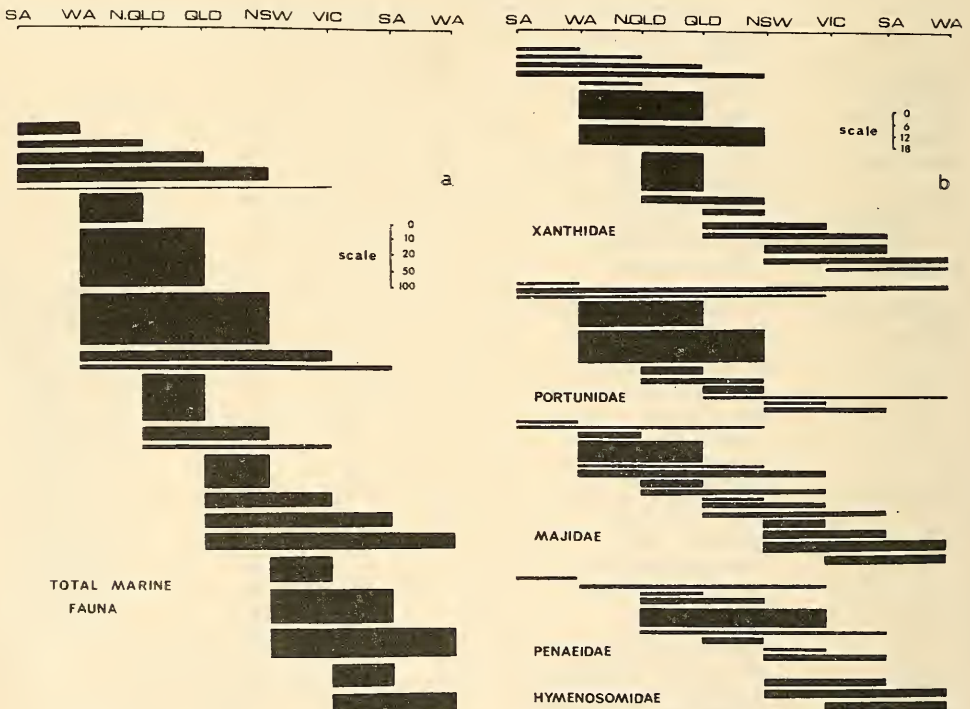


Fig. 2. Diagram showing distribution patterns of Australian marine decapod species known to occur in more than one State; width of each bar is proportional to number of species showing each particular pattern of distribution according to the scales given. a—distribution of all Australian species; b—distribution patterns of the species belonging to five selected families.

Families with more than 2/3 of their Genera World-Wide in Distribution

Large families (i.e., with 10 or more Australian species): Penaeidae, Scyllaridae, Paguridae, Porcellanidae, Galatheidae, Calappidae.

Small families (i.e., with less than 10 Australian species): Sergestidae, Pasiphaeidae, Pandalidae, Oplophoridae, Rhynchocinetidae, Processidae, Crangonidae, Stenopodidae, Nephropsidae, Axiidae, Upogebiidae, Pylochelidae, Coenobitidae, Chirostylidae, Albuneidae, Homolidae, Dorippidae, Cancridae, Gecarcinidae, Hapalocarcinidae.

Families with more than 2/3 of their Genera Indo-West Pacific in Distribution

Large families (i.e., with 10 or more Australian species): Leucosiidae, Majidae, Parthenopidae, Hymenosomidae, Ocypodidae.

Small families (i.e., with less than 10 Australian species): Ogyrididae, Thalassinidae, Laomediidae, Corystidae, Atelecyclidae, Mictyridae.

Families with between 1/3 and 2/3 of their Genera World-Wide or Indo-West Pacific in Distribution

Large families (i.e., with 10 or more Australian species): Palaemonidae, Alpheidae, Hippolytidae, Palinuridae, Dromiidae, Xanthidae, Portunidae, Goneplacidae, Grapsidae, Pinnotheridae.

Small families (i.e., with less than 10 Australian species): Gnathophyllidae, Callianassidae, Hippidae, Raninidae, Palicidae.

TABLE 5
Percentage of total marine decapod species in each state made up by each family

Family	Area—Percentage of Species					
	Qld.	N.S.W.	Vic. and Tas.	S.A.	W.A.	All States
Approx. number of species	700	300	200	200	400	1070
Xanthidae .. 166	16	12	8	10	18	15
Majidae .. 93	7	12	18	12	10	9
Portunidae .. 80	10	10	3	4	11	8
Leucosiidae .. 74	8	4	6	5	8	7
Paguridae .. 58	4	5	6	2	3	5
Palaemonidae .. 48	4	2	—	3	3	4
Grapsidae .. 43	5	5	6	4	2	4
Ocypodidae .. 41	5	3	1	0.5	4	4
Penaeidae .. 51	8	6	4	2	4	4
Porcellanidae .. 38	4	2	3	1	7	3
Alpheidae .. 31	3	2	4	7	1	2
Parthenopidae .. 29	4	1	—	1	2	2
Dromiidae .. 24	1	2	3	6	2	2
Goneplacidae .. 21	2	3	3	2	0.5	1.5
Hippolytidae .. 19	0.5	1	1.5	3	1.5	1.5
Scyllaridae .. 15	1	2	1	—	1.5	1.5
Calappidae .. 14	1.5	2	—	1.5	3	1.5
Pinnotheridae .. 12	1	0.5	1.5	1.5	1	1
Palinuridae .. 11	1	1.5	1	0.5	1.5	1
Galatheidae .. 11	1	2	2	0.5	0.5	1
Hymenosomidae .. 10	—	1	2.5	2.5	1	1
Others .. 111	13	21	24.5	34	13.5	21

Families and Genera with Asiatic Representation

The families Atyidae and Potamidae (both freshwater), and representatives of the following families: Majidae (*Leptomithrax*, *Sargassocarcinus*); Xanthidae (*Hypothalassia*, *Calvactea*, *Liagore*); Grapsidae (*Utica*); Palicidae (*Pleurophrycus*).

Genera with a Wide, Southern Temperate Distribution

Genera, with family name in brackets, as follows: *Nauticaris* (Hippolytidae); *Campylonotus* (Campylonotidae); *Jasus* (Palinuridae); *Notomithrax* (Majidae); *Halicarcinus* (Hymenosomidae); *Leptograpsus* and *Cyclograpsus* (in part) (Grapsidae); *Nectocarcinus* (Portunidae).

Some Genera with Other Distributions

Indopacific and South Atlantic: *Mursia* (Calappidae).

Indopacific and West African: *Epixanthus*, *Heteropanope*, *Pilumnopus* (Xanthidae).

Indopacific and West Indies: *Chlorodiella*, *Carpilius*, *Phymodius* (Xanthidae); *Ovalipes* (Portunidae).

Indopacific and Eastern Pacific (but not Atlantic): *Pugettia* (Majidae); *Daira*, *Carpilodes*, *Trapezia* (Xanthidae).

More than two thirds of the included genera in almost one half of the families occur throughout the world, whilst 1/5 of the families are mainly Indo-West Pacific. Slightly less than one third of the families have mixed relationships. A few genera, each including only a small number of species

TABLE 6

Number of species per state expressed as a percentage of the total number of species in each family

Family	Approx. Number of Species	Area—Percentage of Species				
		Qld.	N.S.W.	Vic. and Tas.	S.A.	W.A.
Xanthidae	166	61	20	7	10	42
Majidae	93	48	36	34	23	41
Portunidae	80	75	38	10	7	56
Leucosidae	74	71	15	13	12	46
Paguridae	58	40	26	15	7	19
Palaemonidae	48	48	11	0	11	22
Grapsidae	43	80	38	22	20	21
Ocypodidae	41	81	25	5	2	47
Penaeidae	51	90	35	11	9	34
Porcellanidae	38	61	16	7	5	74
Alpheidae	31	60	16	20	47	20
Parthenopidae	29	80	10	0	10	29
Dromiidae	24	31	26	21	40	31
Goneplacidae	21	49	40	20	20	5
Hippolytidae	19	15	15	15	40	30
Scyllaridae	15	51	48	12	0	34
Calappidae	14	70	50	0	22	80
Pinnotheridae	12	40	9	25	25	45
Palinuridae	11	85	61	24	10	75
Galatheididae	11	85	72	48	9	18
Hymenosomidae	10	0	40	50	50	40
Others	111	90	50	70	65	60

in Australia, are distributed mainly through the southern temperate areas of the Indo-Pacific. The freshwater families, Atyidae and Potamidae, as well as a few marine genera, are largely confined to Australia and the Indo-Malayan area. Finally, a small number of genera, mainly xanthids, have unusual distributions.

Twenty-nine genera are not known outside Australia; many of these are monotypic. The following is a list of these restricted and often poorly known taxa.

Genera Endemic (i.e., restricted) to Australia

Freshwater genera and families: *Caridinides*, *Stygiocaris* (Atyidae); ten genera of Parastacidae (i.e., all except *Cherax*).

Marine genera, with family names in brackets, as follows: *Vercoia* (Crangonidae); *Lomis* (Lomisidae); *Epipedromia* (Dromiidae); *Lisso-*



Fig. 3. Histogram showing percentage of total species per family per State for each of four selected families compared with percentage State representation of total Australian marine decapod fauna.

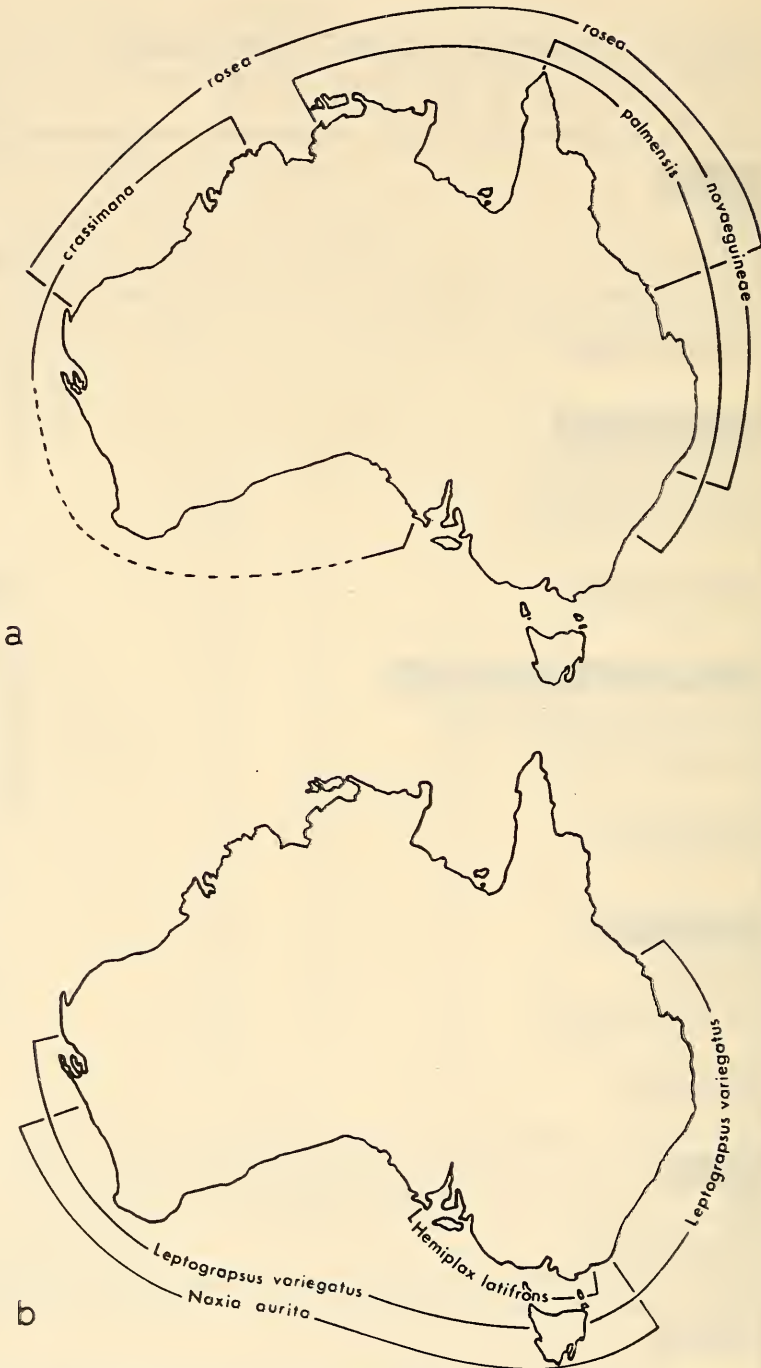


Fig. 4. a—Distribution of the stridulating group of penaeid prawns of the genus *Metapenaeopsis* showing various patterns of northern distribution. b—Distribution of of the ocypodid crab *Hemiplax latifrons*, the majid crab *Naxia aurita* and the grapsid crab *Leptograpsus variegatus* showing three patterns of southern distribution.

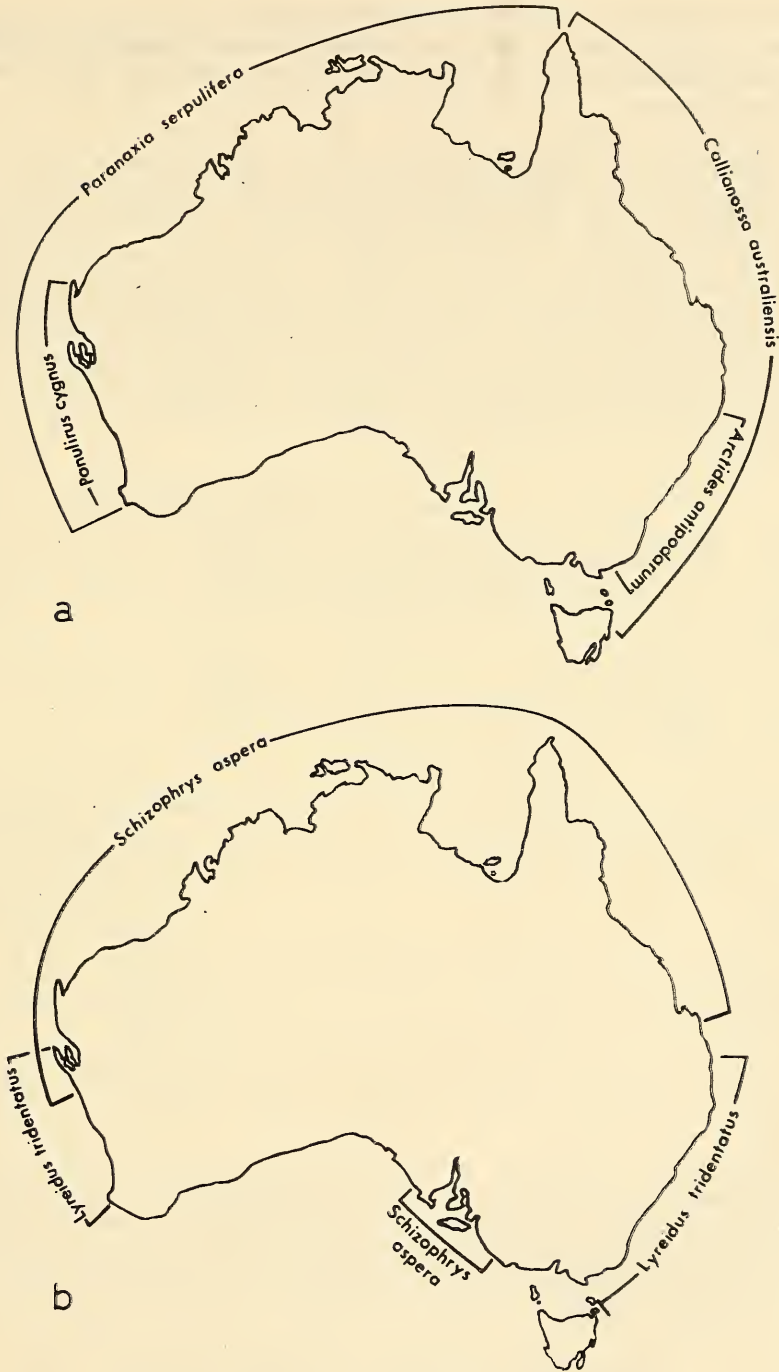


Fig. 5. a—Distribution of the palinurid crayfish *Panulirus cygnus* and the majid crab *Paranaxia serpulifera* showing two types of western distribution pattern; and of the callinassid “yabby” *Callinassa australiensis* and the scyllarid lobster *Arcidides antipodarum* showing two types of eastern distribution pattern. b—Distribution of the raninid crab *Lyreidus tridentatus* and the majid crab *Schizophrys aspera* showing two types of discontinuous distribution.

morpha (Leucosiidae); *Tumulosternum*, *Paramithrax*, *Paranaxia*, *Ephippias* (Majidae); *Leptograpsodes*, *Helograpsus*, *Paragrapsus* (Grapsidae); *Banarelopsis*, *Paraetisis*, *Pseudocarcinus*, *Prolybia* (Xanthidae); *Heloccius*, *Australoplax* (Ocypodidae).

TROPICAL AND TEMPERATE SPECIES AND THEIR DISTRIBUTIONS

An analysis of the distributions of the species belonging to five family groups (Table 7) show that a large proportion of the tropical species are widespread throughout the Indo-West Pacific. Generally a smaller proportion is either shared with part of the Indian Ocean or the Western Pacific, though a sizeable number of Australian species are not known outside the Indo-Malayan Archipelago—in the penaeine prawns this last group is particularly large. The temperate group is characterized by a very large number of species which are restricted to Australia; among the temperate majids a small percentage is shared with southern temperate areas outside Australia.

TABLE 7
Distributions of species outside Australia for five family groups

Family	Total No. Species	Percentage of Total Species per Distribution Type Partitioned according to Area							Percentage of Total	
		Restricted	Indo-Malay	Indian Ocean	West Pacific	Widespread	Southern			
Portunidae ..	80	19	10	11	8	52	0	91	Tropical Australia	
		66	0	0	0	34	0	9	Temperate Australia	
Majidae ..	93	17	15	10	15	43	0	65	Tropical Australia	
		67	0	2	11	6	14	35	Temperate Australia	
Oxystomata..	45	17	4	24	9	46	0	82	Tropical Western Australia	
		66	6	22	0	12	0	18	Temperate Western Australia	
Porcellanidae	30	21	11	12	18	38	0	88	Tropical Western Australia	
		100	0	0	0	0	0	12	Temperate Western Australia	
Penaeinae ..	40	38	21	8	15	18	0	92	Tropical Australia	
		100	0	0	0	0	0	8	Temperate Australia	

The fauna as a whole is not as yet well enough known to allow an analysis of the representation of the main Indo-Pacific elements in the various areas of Australia. Thus in the majids, whilst at present the western Australian fauna appears to contain a larger percentage of Indian Ocean species than does the eastern Australian fauna, this may be due to the fact that the western Australian fauna is the poorer known.

CONCLUSIONS—PRESENT AND FUTURE WORK

Much of what has been outlined above would apply to most groups of Australian marine animals—tropical groups tend to be widely distributed, whereas cool temperate animals tend to have limited distributions. Zoogeographically, the Australian decapod fauna appears to have been derived almost entirely from the tropical Indo-Pacific region. There seems to be no

good evidence to suggest that temperate species have reached Australia directly from temperate areas outside Australia.

The following concluding remarks attempt to summarize what is at present known about each of the main systematic groups. It should be pointed out that few parts of the Australian coastline, continental shelf and off-shore oceanic waters have been well sampled thus far, whilst the continental slope beyond 100 fms. is virtually unknown. Almost the whole of the area around north-western Australia and the Great Australian Bight is unexplored.

The penaeid prawns are continuing to be actively investigated by A. A. Racek of the University of Sydney. Almost nothing is known about the identity and distribution of the pelagic and bathypelagic shrimps (Sergestidae, Pasiphaeidae, Ophlophoridae), nor about the shelf and archibenthal, possibly commercial, natants (e.g., Pandalidae and Crangonidae); only the *Challenger* Expedition (1873-76) has provided as yet any substantial information on these groups in Australian offshore waters. However, New Zealand representatives have been recently reviewed (Richardson and Yaldwyn, 1958; Yaldwyn, 1960).

Among the most complex and taxonomically difficult groups of natants are the Alpheidae (snapping shrimps—see Banner and Banner, 1966), the Australian members of which are currently being revised by A. H. and Dora M. Banner of the University of Hawaii. The other main natant group—the Palaemonidae—is perhaps reasonably well known; the pontonines (mainly tropical commensals—see Bruce, 1967) are now being studied by A. J. Bruce of the C.S.I.R.O. Division of Fisheries and Oceanography and the palaemonines have been briefly investigated by a few workers (e.g., Holthuis, 1952). Our comprehension of the freshwater species of the genus *Macrobrachium* and of the freshwater shrimps of the family Atyidae, is almost abysmal—nothing definitive is known of the individual distributions, or of the range of variation in these forms. The general zoogeography and relationships of all freshwater decapod genera has, however, been reviewed in detail by Bishop (1967).

For most of the reptant macrurans our knowledge is more advanced. The status of the palinurids is probably better known than that of any other group of decapods, and they are under continuing study by R. W. George of the Western Australian Museum and L. B. Holthuis of the Rijksmuseum, Leiden (George and Holthuis, 1965). Holthuis has also nearly completed revisionary studies on the Scyllaridae. Two major systematic revisions of the Parastacidae are being completed by E. F. Riek of the C.S.I.R.O. Division of Entomology and D. D. Francois of the N.S.W. Chief Secretary's Department Fisheries Division.

Not a great deal is known of the very large and varied group, the Anomura. Only the Porcellanidae are reasonably well known, the western species having recently been studied by Janet Haig of the Allan Hancock Foundation, Los Angeles (Haig, 1965) and she is soon to commence intensive studies on the remainder of the Australian fauna. Information about the pagurids is almost totally absent for the whole Indo-Pacific (with the exception of south-east Asia where the species have been studied by Fize and Serène, 1955); this is in contrast to the fairly well-known Atlantic fauna (see Gordan, 1956). The position of the monotypic Lomisidae has been investigated recently by Pilgrim (1965).

In the Brachyura a few groups have been studied in varied detail, but most are still poorly known. Knowledge of the leucosiids, calappids and

raninids has been given a basis in the recent studies by Marina Tyndale-Biscoe and R. W. George (1962), and by W. Stephenson of the University of Queensland (pers. comm.). These oxystomes are one of the groups where further revisionary studies could be completed fairly easily in the near future.

In the case of the oxyrhynchs (Majidae, Parthenopidae and Hymenosomidae), one of us (D.J.G.G.) is continuing investigation of the majids; a fairly large number of new species remain to be added to the fauna and many species known from eastern Australia are present in western waters, but have not so far been recorded formally. Studies on the parthenopids have been initiated; the most recent relevant studies are by Flipse (1930) and Serène (1954, 1955). The Hymenosomidae exhibit their greatest diversity in Australasia (Tesch, 1918*a*), yet knowledge of them is almost entirely lacking; the work of J. S. Lucas, of the University of Western Australia (pers. comm.), on reproductive isolation and general biology, should provide a sound basis for future work on the Australian species.

The portunids continue to undergo intensive study by W. Stephenson and his co-workers at the University of Queensland; this group is one of the best known of Australian crabs. The very large and complex group, the Xanthidae, are currently being revised on a world-wide basis by Danièle Guinot of the National Museum, Paris (see Forest and Guinot, 1961); previous knowledge of Australian species comes mainly from the works of Melbourne Ward (see Whitley, 1967). The Goneplacidae appear at present to make up rather a small proportion of the brachyuran fauna but it should be pointed out that several small and taxonomically difficult subfamilies await study; many Indo-West Pacific species have been recently documented by Serène (1964).

The behaviourally and ecologically very interesting shore crabs of the families Grapsidae and Ocypodidae are perhaps reasonably well known in the Indo-Pacific (Banerjee, 1960; Crosnier, 1965) and several groups are currently under review in Australia. Local species of the first family are being studied by B. M. Campbell of the Queensland Museum (Campbell, 1967; Campbell and Griffin, 1966) who is particularly interested in the complex group belonging to the genus *Sesarma*. R. Serène of the National Museum, Singapore, is revising at the same time the Indo-Pacific species of *Sesarma*, and one of us (D.J.G.G.) is investigating the distribution of, and variation in, several widespread shore crab species (Griffin, in press). The macrophthalmine ocypodids are currently being revised by R. S. K. Barnes (1966*a, b*). The fiddler crabs (*Uca* species) are in an unusual position taxonomically (see Crosnier, 1965); a very sound basis for work on these species was provided by studies on American species in the 1940's by Jocelyn Crane who has more recently briefly investigated most of the Indo-Pacific species (Crane, 1957). Several workers in Australia are variously interested in this group and know something of the distribution and status of local species, based mainly on recent ecological studies by W. Macnae (1966) of Witwatersrand University, Johannesburg. However, nothing substantial is at present being done by anybody on Australian members of this genus. The western Australian ghost crabs (*Ocypode* species) have recently been studied by R. W. George and Mary Knott (1965).

Nothing is known of two interesting families of mainly commensal species; the Pinnotheridae (see Tesch, 1918*b*; Serène, 1964), which undoubtedly contain many more Australian species than are currently recognised and the Hapalocarcinidae of which almost nothing is known in Australia, although

the south-east Asian fauna has recently been thoroughly documented by Fize and Serène (1957).

Undoubtedly a lot of work remains to be done. Most importantly, knowledge must be obtained of the distributions and patterns of variation within species. Work along these lines might be considered as preceding systematic rearrangements and generic revisions in those cases where identification of taxa at the generic level is not impossible. It is to be earnestly hoped that currently available knowledge concerning some groups will be fully exploited in the near future in conjunction with ecological studies. Species exist in nature, not merely in a bottle or in a person's mind, it is the systematist's job to find them.

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